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STATE OF THE OLFACTORY FUNCTION IN ZINC PRODUCTION WORKERS

/O Sostoyanii Obonyatel'noy Funktsii u Rabochikh Tsinkovogo Proizvodstva/

by

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Results are presented from a study of the olfactory function in 301 workers in zinc production plants, subjected to exposure to a number of chemical compounds, and in 63 workers in a control group. A statistically valid rise was found in the olfactory thresholds to olfactive and trigeminal stimuli, a contraction of the adaptation time to a threshold dose, and prolongation of the recovery period after loading with an olfactory substance. First-degree hyposmia was most often observed. In isolated cases, anosmia was found. The author assumed that the basis of of the olfactory disturbance in zinc production workers is the change both in the peripheral and in the central divisions of the olfactory analyzer.

Change in the olfactory function can be one of the early symptoms of unfavorable exposure of workers' organisms to production factors

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(Yu. S. Kagan, F. M. Shleyman, 1955; R. V. Borisenkova et al., 1957; I. B. Soldatov, 1967, etc.).

We became interested in the problem of the state of the olfactory function in workers engaged in zinc production. In the literature we found only the study by F. I. Marchenko (1967), indicating the state of the olfactory function as a whole for workers in zinc production, without allowing for differences in working conditions at individual stages of zinc production. The author found a statistically reliable rise in the olfactory thresholds, an increase in the adaptation time to the threshold dose, and a rise in the period of recovery after loading with an olfactive substance in these workers. The degree of olfactory disturbance depended on the condition of the nasal mucosa.

Depending on the features of the production process, all zinc production consists of roasting, leaching, and electrolytic stages. From hygiene study data (N. S. Pakhotina and A. F. Soklakov, 1964; V. A. Benediktov and N. S. Zharkova, 1969), polymetallic dust, zinc oxide, sulfur dioxide, and sulfur trioxide were detected in the atmosphere of the roasting department; sulfuric acid, sulfates of zinc and of cadmium, and also hydrogen compounds of fluorine, chlorine, arsenic, antimony, and other elements — in the atmosphere of the leaching and electrolytic departments. The concentrations of these substances in many work stations exceeds the maximum permissible limits by several times.

From the literature data we know that these compounds have an irritating or caustic effect on the mucosa of the upper respiratory passages and in addition most of these compounds exhibit a general-toxic action

when resorbed (T. N. Mil'shteyn, 1928; N. P. Sterekhova, 1959; A. G. Levshova, 1960). A study we conducted (G. Ye. Pyatayev, 1968) of the condition of the mucosa of the upper respiratory passages in zinc workers showed that in most cases they have moderate hyperemia of the mucosa in all levels of the upper respiratory passages, and often with cyanosis of this mucosa. Moreover, the following was found in the anterior division of the nose: anterior dry rhinitis, whitish patches on the mucosa and their erosion, and in some persons -- perforation in the cartilaginous division of the nasal septum. These changes in frequency and intensity were the smallest for workers in the roasting department, and the highest -- for workers in the electrolytic department.

Upon exposure to certain compounds of the above-indicated complex of chemicals, changes develop in the olfactory function (R. M. Sklyanskaya et al., 1935; V. G. Osipova, and L. G. Okhnyanskaya, 1954; R. S. Vorob'yeva, 1957; A. V. Luzina, 1960; and others).

We investigated the olfactory function in 301 zinc production workers, 103 of which worked in the roasting department (86.4 percent men and 13.6 percent women), 91 -- in the leaching department (62.6 percent men and 37.4 percent women), and 107 -- in the electrolytic department (73.5 percent men and 26.5 percent women). For comparison, a similar study was made of 63 workers in the machine shop of a machinebuilding plant (control group) not exposed to polymetallic dust or the chemicals. Among the zinc production workers, 78.6 percent were in the age group 20-39 and 21.4 percent -- in the age group 40-49 years of age; 30.4 percent of those examined had a work history up to 5 years and 69.6 percent -- more than 5 years. The distribution was approximately the same for age and work experience for the control group workers.

An olfactometer as modified by B. A. Shaparenko (1959) was used to determine the olfactory thresholds (monorhinally), adaptation time to the threshold dose, and recovery period after loading with an olfactive substance. Peppermint drops were used as the stimuli, a substance with predominantly olfactory action (B. A. Shaparenko, 1959; V. Ye. Parilov and R. M. Gofshteyn, 1966) and a 30 percent acetic acid solution exhibiting mixed action with a trigeminal component (M. S. Medvedovskiy, 1955; B. A. Shaparenko, 1949). The odorant mixture was metered with a syringe. In examining healthy individuals by this method, the olfactory thresholds were found to vary from 2.0 to 4.0 cm^3 of peppermint drop vapor, or 30 percent acetic acid solution. We took these values as the norm. The olfactory thresholds in the range 5.0 to 10.0 cm^3 were rated as first-degree hyposmia, values in the range 11.0 to 15.0 cm^3 -- as second-degree hyposmia, and the values in the range 16 to 20 cm^3 -- as third-degree hyposmia. Failure to detect odor when 30 cm^3 of the odorant stimulus was administered into a nostril was recorded as anosmia. The data collected were subjected to statistical interpretation.

Analysis of the findings of the study of the olfactory function showed that in most workers the olfactory thresholds are increased to varying degrees. Among workers studied in the roasting department, a rise in the thresholds to the olfactive substance was found in 70.0 percent, in 56.2 percent of leaching department workers, and in 60.4 percent of electrolytic department workers. This same indicator for the trigeminal stimulus showed a rise in 74.0 percent of the roasting department workers, in 58.5 percent of the leaching department workers, and in 59.6 percent of the electrolytic department workers. In the control group, a rise in

thresholds to the olfactive substance was found in 6.4 percent of those studied, and in 26.9 percent -- a rise in the thresholds to the trigeminal substance. The distribution of workers in the various zinc departments is shown in Table 1 with respect to degree of hyposmia; from the data it is clear that in all zinc production departments approximately one-third of the workers showed normal olfactory thresholds, while the rest had increased thresholds. First-degree hyposmia was found most often, and much less frequently -- second- and third-degree hyposmia. In each department cases of anosmia to the odorants used was observed, and this condition was found in individuals with a zinc production work history upwards of 5 years. Approximately the same indicators of reduction in the olfactory function were found for stimulation with the trigeminal substance. The asymmetry in the olfactory thresholds of the right and the left nostrils, as a rule, was limited and did not exceed 1.0-3.0 cm^3. The mean values of the olfactory thresholds (Table 2) in each department exceeded those in the control group by approximately a factor of 2, and the difference in these values was statistically reliable ($t > 3.0$). The same correlation was observed both for stimulation with the odor of peppermint drops as well as with acetic acid. Comparison of the mean olfactory thresholds in workers with a work history up to 5 years with this index in workers with a work history upwards of 5 years, and also between individuals in the main and auxiliary occupations showed that their difference is statistically unreliable in most cases ($t < 3.0$), both for stimulation with the olfactive as well as with the trigeminal substances.

The difference in the mean olfactory thresholds in the workers in the roasting and leaching departments, as well as those in the roasting and electrolytic departments is statistically reliable ($t > 3.0$); but a comparison of the same indicators for workers in the leaching and electrolytic departments gave a statistically unreliable result ($t < 3.0$). This correlation was found also in the thresholds to stimulation both with the peppermint drops as well as with acetic acid. It can be assumed that the cause of this correlation is the fact that workers in the roasting department are exposed to sulfur dioxide, which itself is a competent stimulus of the olfactory analyzer and can act also on the endings of the trigeminal nerve, inducing tactile sensation (A. I. Bronshteyn, 1950). Extended exposure of the receptor to this gas can possibly lead to fatiguing of the olfactory analyzer, which is expressed in a rise in thresholds. Vapor of acids and oxides of heavy metals contained in the atmosphere of the leaching and electrolytic departments evidently is not a competent stimulus of the olfactory analyzer and can act only on the mucosa of the olfactory region or else by way of the general-toxic effect when these substances are resorbed.

Thus, the olfactory thresholds of peppermint drops and acetic acid in most zinc production workers are higher by differing degrees. Most often a mild degree of hyposmia is observed, and much less often -- more severe degrees of hyposmia. Anosmia to the odorants used was observed in several cases in workers with extended work history.

One of the indicators of the state of the olfactory analyzer was a study of the process of adaptation to the threshold dose of the odorant.

Our data on this problem showed that in many zinc production workers the adaptation occurs faster than in the control group. The adaptation time to the threshold dose to the olfactory stimulus in zinc workers varied from 1 to 4 minutes, while it varied from 2 to 10 minutes in the control group. The same figures were obtained for adaptation to the threshold dose of the trigeminal substance. The mean adaptation times for both olfactory stimuli (Table 2) in workers in all zinc production departments were shorter than for workers in the control group — by about a factor of 2; their difference is statistically reliable. A comparison of the mean adaptation times of workers in the group of the main occupations and the auxiliary occupations in most cases yielded a statistically unreliable difference; the same correlation was observed when these values were compared for workers on the job for up to 5 or more than 5 years.

Table 1

Distribution of Zinc Production Workers by Degree of Hyposmia to Peppermint Drop Odorant

1 Отделение	2 Всего обследовано	3 Пороги в пределах нормы	4 Степень гипосмии I	II	III	5 Аносмия
Обжиговое 6	103	30	59	9	2	3
Выщелачивательное 7	91	39	47	3	—	2
Электролизное 8	107	41	60	1	2	3
Контроль 9	63	59	4	—	—	—

Key:
1. Department
2. Total examined
3. Thresholds within normal limits
4. Degree of hyposmia
5. Anosmia
6. Roasting
7. Leaching
8. Electrolytic
9. Control

[Translator's note: Commas in the tabulated figures are equivalent to decimal points.]

Table 2

Mean Values (M ± m) of Indicators of the Olfactory Function in Zinc Production Workers and in Control Group Workers

Отделение 1	Раздражитель 2					
	Порог обоняния (в см³) 3		Время адаптации (в минутах) 4		Период восстановления (в минутах) 5	
	Ольфактивный 6	Тригеминальный 7	Ольфактивный 6	Тригеминальный 7	Ольфактивный 6	Тригеминальный 7
Обжиговое 8	6,96±0,29	7,04±0,28	2,23±0,10	2,20±0,10	3,50±0,13	3,72±0,13
Вышелачивательное 9	5,64±0,19	5,66±0,17	1,90±0,10	2,0 ±0,11	4,10±0,17	3,90±0,16
Электролизное 10	5,85±0,23	5,46±0,15	1,86±0,12	2,15±0,11	3,64±0,11	3,66±0,12
Контроль 11	3,0 ±0,13	3,60±0,18	4,30±0,30	4,06±0,18	2,03±0,13	1,84±0,15

Key:
1. Department
2. Stimulus
3. Olfactory threshold (in cm^3)
4. Adaptation time (in minutes)
5. Recovery period (in minutes)
6. Olfactive
7. Trigeminal
8. Roasting
9. Leaching
10. Electrolytic
11. Control

[Translator's note: Commas in the tabulated figures are equivalent to decimal points.]

The recovery process after loading with one of the odorants in most zinc plant workers occurs more slowly than in the control group: in the former the recovery period varies from 1 to 6 minutes, and in the latter -- from 1 to 3 minutes. The mean values of this indicator (Table 2) in zinc production workers exceed those for the control group and the difference is statistically reliable. A comparison of these same values for persons working for up to 5 years with persons working more than 5 years, and for workers in the main occupations with workers in the auxiliary occupations was generally statistically unreliable.

Based on data from the study of adaptation to the threshold dose and of recovery after loading with the olfactive substance, it can be

assumed that in zinc workers these processes are disturbed in the direction of a reduction in the functional capacity of the olfactory analyzer.

Thus, the results of studying the olfactory function (olfactory thresholds, adaptation time, and recovery period) in workers of various zinc production departments compared with the control group are statistically reliable. Since the difference in the working conditions of these groups lies in the presence of a complex of noxious chemical compounds in the atmosphere of the zinc production work stations and in the air of the machine shop in the machinebuilding plant, while as to age, sex, work history, and social-household conditions these groups are approximately the same, we can assume that the change in the olfactory function in zinc production workers in most cases is caused by exposure to these chemicals.

The above-presented complex of chemical compounds evidently affects both the peripheral and the central divisions of the olfactory analyzer. The following mechanism of action on its peripheral division can be suggested: extended multiple stimulation of the mucosa of the olfactory region with noxious chemical compounds inhaled with air leads to stagnant hyperemia of this mucosa. When stagnant hyperemia is present, it is possible that the trophism of the olfactory epithelium is disturbed, which leads to the reduced functionality of this analyzer. Action on the central division probably occurs due to the general toxic effect when noxious substances are resorbed.

Starting from the fact that underlying the change in the olfactory function of zinc production workers is exposure to chemicals contained

in the atmosphere of working quarters, it must be assumed that preventive measures must aim at improving the hermetization of equipment along the entire production line, which would prevent the release into the atmosphere of work stations of noxious vapors and gases.

Conclusions

1. The olfactory function in zinc production workers is characterized by a statistically reliable rise in the olfactory thresholds to olfactive and trigeminal substances, contraction of the adaptation time to the threshold dose of the odorant stimulus, and extension of the recovery period after loading with the olfactive substance; anosmia was observed in individual cases.

2. The disturbance in the olfactory function is expressed more often in roasting department workers compared with workers in other zinc production departments.

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